Southwest Center for Microsystems Education (SCME)
University of New Mexico

Biomolecular Applications for bioMEMS Learning Module

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This learning module is an overview of biomolecules, what are they, types of biomolecules, and how microtechnology is using biomolecules or exploiting their functions for micro and nano-sized transducers, sensors and actuators. Activities provide the opportunity to better understand the function of biomolecules, their scale and why they are so important for micro and nanotechnologies.

Target audiences: High School, Community College, University

Website: www.scme-nm.org

Biomolecular Applications for bioMEMS – Knowledge Probe (KP)
Instructor Guide

Notes to Instructor

This learning module is an overview of biomolecules, what are they, types of biomolecules, and how microtechnology is using biomolecules or exploiting their functions for micro and nano-sized transducers, sensors and actuators. Activities provide the opportunity to better understand the function of biomolecules, their scale and why they are so important for micro and nanotechnologies.

This Knowledge Probe is a pre-assessment that helps to evaluate the participants' knowledge of biomolecules and the characteristics that make biomolecules capable of being used in bioMEMS devices prior to completing this learning module. This KP could be compared against the post-test results to help determine the effectiveness of this module.

This KP is part of *Mapping Biological Concepts* which contain the following learning module:
- DNA Overview
- DNA to Protein Overview
- Cells – The Building Blocks of Life
- Biomolecular Applications in bioMEMS

This unit is the *KP* for the *Biomolecular Applications for bioMEMS Learning Module*:
- **Knowledge Probe (KP or pre-test)**
- Biomolecular Applications for bioMEMS Primary Knowledge
- Biomolecular Functions - Activity
- The Scale of biomolecules – Activities
- Biological Motors – Activity
- Biomolecular Applications for bioMEMS Assessment

There are ten questions and a matching chart. Answers are indicated in red.

Knowledge Probe Description

This learning module is an overview of biomolecules, what are they, types of biomolecules, and how microtechnology is using biomolecules or exploiting their functions for micro and nano-sized transducers, sensors and actuators. Activities provide the opportunity to better understand the function of biomolecules, their scale and why they are so important for micro and nanotechnologies.

The purpose of this knowledge probe is to help you to determine what you already know about biomolecules, their functions and their applications within microtechnologies. There is a matching problem and ten questions. Answer to the best of your knowledge.

Matching (with answers)

Indicate the BEST type of biomolecules to perform each of the bioMEMS functions listed below.

		BioMEMS Function		**Type of biomolecule**
B	1	Recognizing the presence of a pathogen by a unique pathogen DNA sequence	A	Proteins
A	2	Filtering large macromolecules from smaller molecules in a complex solution	B	Nucleic acids
C	3	Forming a container for a water-soluble drug	C	Lipids
A	4	Sensing the presence of an environmental pollutant		
A	5	Moving a particle across the surface of a bioMEMS device		
A	6	Detection of changes in blood sugar levels in diabetic patients		
B	7	Detection of a disease state by changes in expression levels of key genes		
A	8	Catalyzing a specific chemical reaction		

Table 1: BioMEMS Functions vs. Biomolecule

1.   **Which of the following has the smallest size?**
      a. distance across a lipid bilayer
      b. diameter of a microtubule
      c. diameter of a DNA double helix
      d. diameter across a liposome vesicle
      e. diameter of a bacterial flagellum

Answer: c. Diameter of a DNA double helix

2.   **Which of the following has the largest size?**
      a. distance across a lipid bilayer
      b. diameter of a microtubule
      c. diameter of a DNA double helix
      d. diameter across a liposome vesicle
      e. diameter of a bacterial flagellum

Answer: d. diameter across a liposome vesicle

3.   **Which type of protein has the largest channel diameter?**
      a. Bacterial membrane porins
      b. Bacterial S-layer proteins
      c. Microtubules
      d. Tobacco Mosaic virus

Answer: c. Microtubules

4.   **Which of the following best explains the reason that biomolecules have such specific recognition properties?**
      a. Nonpolar and hydrophobic interactions
      b. Polar and hydrophilic interactions
      c. Both nonpolar/hydrophobic and polar/hydrophilic interactions
      d. A specific covalent bond in a lock and key type of position

Answer: c. Both nonpolar/hydrophobic and polar/hydrophilic interactions

5.   **Which of the following properties of biological molecules is NOT an advantage in bioMEMS applications?**
    a. Ability to self-assemble, based on inherent chemical and surface interactions
    b. Ability to self-renew, providing a self-assembling and self-perpetuating property
    c. Precision in the structures that they form
    d. Their highly discriminating recognition properties
    e. Nanoscale size of their structures

Answer: b. Ability to self-renew, providing a self-assembling and self-perpetuating property is NOT an advantage in bioMEMS applications

6.   **Which of the following proteins would be best suited for moving particles to different positions on a bioMEMS surface?**
    a. Kinesin and microtubules
    b. Kinesin and actin microfilaments
    c. Flagellin motor proteins and flagellin proteins
    d. Myosin and flagellin proteins
    e. ATP synthase and flagellin proteins

Answer: a. Kinesin and microtubules

7.   **Which of the following requires a lipid membrane in order to function?**
    a. A glucose oxidase enzyme that binds to glucose molecules and oxidize them
    b. A DNA microarray
    c. A protein microarray
    d. ATP synthase
    e. Microtubules

Answer: d. ATP synthase

8.   **Which of the following could be used for transfer of small molecules into or out of lipid vesicles?**
    a. Bacterial porin and transmembrane channel proteins
    b. Bacterial porin proteins only
    c. Transmembrane channel proteins only
    d. Transmembrane receptor and cell surface receptor proteins
    e. Cell surface receptors only

Answer a. Bacterial porin and transmembrane channel proteins

9.   **Which of the following would be best suited for a protein microarray?**
   a. Single-stranded DNA molecules
   b. Cell surface receptors
   c. Antibodies
   d. Bacterial S-layer proteins

   Answer: c. Antibodies

10.   **Which of the following stimuli could be used to provide power for synthesis of ATP by the enzyme ATP synthase?**
   a. Binding of a specific activator in the enzyme active site
   b. A sudden shift in pH
   c. Addition of a proton-carrier protein
   d. Coupling this enzyme with another enzyme that makes ADP available

   Answer: b. A sudden shift in pH